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Effect of Phosphorus Treatments on Lead Mineralogy in Contaminated Soils
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Beamline(s): X11A

Introduction: Pb contaminated soils have observed reduction in Pb bioavailability after phosphorus amendments. Test plots set up at Joplin, MO examined the effectiveness of various P, Fe, and/or biosolids treatments in reducing Pb bioavailability. XANES analysis was useful in finger printing the various Pb forms in the soil samples, which consisted of adsorbed Pb, Pb-carbonate, Pb-sulfur, and Pb-phosphate (pyromorphite) species.

Methods and Materials: The soil samples were collected from the Joplin field site after 32 months of reaction and sieved to collect the <250 μm size fraction. Data was collected in fluorescence using a Lytle detector to encompass the XANES region of Pb. Principle component analysis was used to decipher the XANES spectra relative to know reference compounds and the data are presented on a weighted basis from the fitting procedure.

Results: The overall objective of this study was to transform the soil-Pb to stable pyromorphite. The treatments will be described in three groups: P only, P and Fe, and P and biosolids amendments. However, first, the control samples were dominated by adsorbed Pb, Pb-carbonate, and Pb-sulfur species. In the P only treatments (Figure 1), pyromorphite formation was evident in each case but other Pb forms were also present suggesting there is not a complete conversion of soil-Pb to pyromorphite. The P and Fe treatments (Figure 2) saw increases in the amount of pyromorphite as both P and Fe concentrations increased. In the biosolids and P treatments (Figure 2), there was limited conversion to pyromorphite and a noticeable increase in adsorbed Pb components. The results of these various amendment treatments will be useful in deciding future applications of this technology.

Conclusions: Conversion of Pb compounds to pyromorphite in ideal systems has been examined in the literature [1-3], however such studies are compounded in complexity for heterogeneous soil systems. XANES analysis was useful in partitioning defined Pb phases (adsorbed Pb, Pb-carbonate, Pb-sulfur, and pyromorphite) to gain an overall view of the Pb speciation in the contaminated soils.

Acknowledgments: The research results presented herein do not, necessarily, reflect Agency policy. Mention of trade names of commercial products does not constitute endorsement or recommendation for use.

References:
1. Zhang, P.C. and J.A. Ryan, *Formation of pyromorphite in anglesite hydroxyapatite suspensions under varying pH conditions.* Environ. Sci. Technol. 1998. **32**(21): p. 3318-3324.
2. Zhang, P.C. and J.A. Ryan, *Transformation of Pb(II) from cerrusite to chloropyromorphite in the presence of hydroxyapatite under varying conditions of pH.* Environ. Sci. Technol. 1999. **33**(4): p. 625-630.
3. Zhang, P.C., J.A. Ryan, and J. Yang, *In vitro soil Pb solubility in the presence of hydroxyapatite.* Environ. Sci. Technol. 1998. **32**(18): p. 2763-2768.

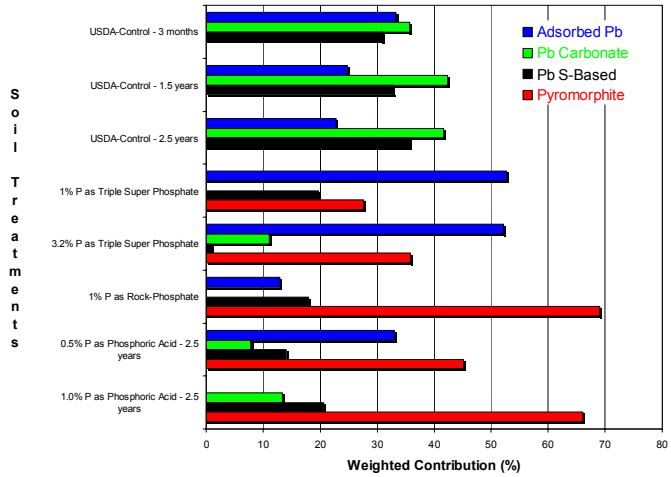

Figure 1. XANES analyses of P only treatments.

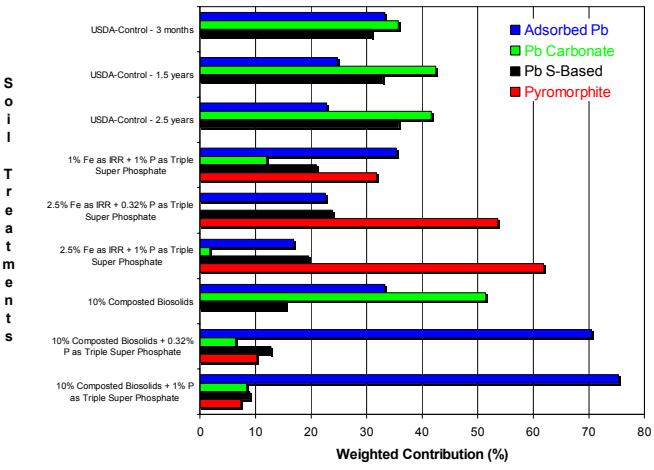

Figure 2. XANES analyses of P with Fe and biosolids treatments.